

## TECHNICAL MEMORANDUM

CH2MHILL

## Background Investigation Results for Select Inorganics NAS Oceana- Virginia Beach, VA

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This technical memorandum summarizes the results of the field effort and groundwater sampling associated with the background investigation at Naval Air Station (NAS) Oceana, Virginia Beach, Virginia. The work plan for this sampling event was finalized in January 2003 and is entitled, *Background Investigation and Hot Spot Groundwater Remediation Pilot Testing at SWMUs 1, 2B, and 24*. The objective for the background field effort identified in the work plan was:

- Installation and sampling of 13 monitoring wells at non-impacted locations to establish background concentrations of Arsenic(As), Iron(Fe), Manganese(Mn), and Lead(Pb).

Statistics were conducted on two rounds of sample results (January and July 2003) to determine comparison values for SWMU-specific inorganic concentrations of As, Fe, Mn, and Pb.

Monitoring well installation was initiated on January 2, 2003. Installation and development took approximately six days to complete. The first round of sampling was performed during the week of January 20, 2003. The second round of sampling was performed the week of July 23, 2003. Details and results of the field effort are summarized below.

### Background Monitoring Well Installation

Thirteen monitoring wells were installed at NAS Oceana in January 2003 in order to establish background concentrations of arsenic, iron, manganese, and lead. Monitoring well locations were selected based upon a review of historical aerial photographs. Locations appeared to be non-impacted by base activities over the years and are shown on Figure 1.

Monitoring wells were installed through 4-1/4-inch-ID hollow stem augers (HSAs). Two foot split spoons were collected at five-foot intervals (5-7' bgs, 10-12' bgs, etc.) during drilling in order to lithologically characterize the borehole. Lithology generally consisted of silty clays, silty sands, and clean sands, coarsening with depth. Wells were installed between 17 and 20 ft bgs. Wells were constructed of 2-inch-ID Schedule 40 PVC casing and screen. The screens were fifteen feet in length with a slot width of 0.010 inches. A clean silica pack of #3

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well gravel was placed around the screen to a depth of one to two feet above the top of the screen. One to two feet of hydrated bentonite powder was placed on top of the sand pack and the remaining annular space was filled with cement-bentonite grout. Each well was equipped with a locking pressure cap and a watertight flush mounted well cover or stick-up casing where appropriate. Monitoring well construction details are included in Appendix A.

All new monitoring wells were developed using a Whale® pump and surge block to remove fine grained material that may enter the well screen. Average development time was 66 minutes. Average volume purged was 65 gallons. Most turbidity values were reduced to below 40 ntu with the exception of BG-MW10 and BG-MW11. Despite their high turbidity values during development, these wells did not show high turbidity values during sampling.

## Groundwater Sampling and Quality Control

Groundwater samples were collected at the 13 background wells in January and July 2003. Figure 1 shows the locations of the background monitoring wells. Wells were sampled using a peristaltic pump with low-flow sampling protocol. Wells were purged prior to sampling in order to remove standing water from the well and ensure that samples were representative of the aquifer. Water quality parameters such as pH, conductivity, turbidity, dissolved oxygen, temperature, salinity, and oxidation/ reduction potential were monitored during purging. Water quality parameters are shown on Table 1. Wells were sampled after water quality parameters stabilized. Stabilization generally took between 25 and 30 minutes. Water levels were measured throughout the sampling process in order to monitor and minimize well drawdown. Background well samples were collected for analysis of total and dissolved As, Fe, Mn, and Pb. Dissolved samples were field filtered. All samples were contained in laboratory prepared and pre-preserved sample containers, packed on ice, and shipped overnight to Severn Trent Laboratories, North Canton, Ohio.

Field Quality Assurance and Quality Control (QA/QC) samples were collected during the field activities in order to evaluate field methodologies (duplicates) evaluate whether cross contamination occurred during sampling or shipping (trip blanks), and establish field ambient conditions (field blanks). Filtration blanks were also collected during each background sampling event to evaluate possible cross-contamination from the field filter. Temperature blanks were included in each cooler so that the lab could confirm cooler temperature to be less than 4 degrees Celsius when the coolers arrived at the laboratory.

## Analytical Results

### Data Tracking and Validation

Field samples and their corresponding analytical tests were recorded on chains-of-custody. Upon receipt of the samples by the laboratory, a comparison to the field information was made to determine if each sample was listed for analysis of the correct parameters. In addition, a check was made to ensure that the proper number of QA/QC samples was collected for each media.

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Analytical results were submitted to a third party data validator for validation. Validated analytical results of detected constituents for the two background sampling rounds are presented in Table 2. Lead was not detected during either round of sampling. Data qualifiers employed during the validation process include J, K, and U. Data qualified with a "J" indicate that the values are estimated. Data may be estimated for several reasons including: exceedance of holding times; intrasample variability; tentatively identified compounds; or if the reported value is below the Contract Required Detection Limit (CRDL) or the Contract Required Quantitation Limit (CRQL). Data qualified with a "K" indicate that the analyte is present, but the reported value may be biased high and the actual value is expected to be lower. Data qualified with a "U" indicate that the analyte was not detected and the associated number indicates the approximate sample concentration necessary to be detected.

#### **January 2003 Background Groundwater Analytical Results**

Validated analytical results of detected constituents for the January round of background sampling are presented in Table 2. Arsenic was detected in samples from seven of the thirteen background monitoring wells. Detected concentrations ranged from 2.7 ug/L to 13.8 ug/L with an average detected concentration of 6.7 ug/L. The corresponding MCL for arsenic is 10 ug/L. There were only two exceedances of this guideline, at MW-BG07 (10.1 ug/L), and at MW-BG09 (13.8 ug/L). All other detections exceeded the EPA Region III Tap Water RBC of 0.045 ug/L. However, the CRQL of 2 ug/L exceeds this guideline as well. Iron was detected in two samples at concentrations exceeding the EPA Region III Tap Water RBC of 11,000 ug/L. Iron was detected at a concentration of 13,900 ug/L in the sample from well MW-BG09 and at 30,100 ug/L in the sample from MW-BG11. Manganese was detected at a concentration above the RBC of 730 ug/L at MW-BG11 (1,680 ug/L). Lead was not detected in any of the samples at concentrations exceeding MCLs or RBCs.

#### **July 2003 Background Groundwater Analytical Results**

Validated analytical results of detected constituents for the July round of background sampling are presented in Table 2. Arsenic was detected in seven of the thirteen background monitoring wells. However, detections from six of the monitoring wells were at concentrations below the detected concentration of arsenic in the field blank. Consequently, they were flagged with a "B" qualifier during data validation and considered non-detects. The concentration of arsenic in the sample collected from MW-BG07 was 12.4 ug/L, in exceedance of the MCL of 10ug/L and the RBC of 0.045 ug/L. The CRQL of 2 ug/L is also in exceedance of the RBC value for arsenic. Iron was not detected in any samples at concentrations exceeding the EPA Region III Tap Water RBC of 11,000 ug/L. Manganese was not detected in any of the monitoring wells at a concentration above the RBC of 730 ug/L. Lead was not detected in any of the samples at concentrations exceeding MCLs or RBCs. Figure 1 shows background well locations and associated water quality guideline exceedances.

## **Statistical Analysis of Background Inorganic Data**

The background concentrations for arsenic, iron, and manganese were evaluated in preparation for eventual statistical comparisons between site and background data. (All results for lead were non-detect so this parameter was not considered.) These comparisons

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can be performed in a variety of ways, including central tendency and individual comparisons. Central tendency comparisons include two-sample t-tests and Wilcoxon Rank Sum tests. Two-sample t-tests are appropriate when both the site and background populations have the same assumed distribution. The Wilcoxon Rank Sum test is a nonparametric approach that essentially represents a comparison of the medians of the two populations and is so named since it makes use of the sum of the ranks of the ordered (smallest to largest concentration for the combined background and site data sets) concentrations. These central tendency comparisons can determine, with statistical confidence, whether the background and site populations, on average, differ from one another.

In an individual comparison, a site result exceedance over a background threshold value may indicate a site population with higher concentration than the background population, or it may simply be an extreme value of the site population. The typical background threshold used is a background upper tolerance limit (UTL) which estimates an upper percentile of the background population. Such a comparison provides an indication of the number and location of site concentrations which have a relatively low probability of stemming from a population equivalent to that of the background.

#### **Calculation of Background UTLs**

A 95%/95% background UTL is an upper bound (with 95 percent confidence) on the background 95th percentile. The calculation of UTLs depends on the distributional assumption. This assumption is the best estimate of the distribution of the parent (or target) population. The key determination of the data distribution was based on the results of the Shapiro-Wilk test (Gilbert, 1987; EPA, 1998).

The Shapiro-Wilk test was performed to test for normality. A significance level of 0.05 was used for this test. If the p-value for the Shapiro-Wilk test was greater than or equal to 0.05 then the distributional assumption was chosen to be normal. If the assumption of normality was rejected, then the data were treated nonparametrically (i.e., no specified distribution is assumed).

The normal UTL was calculated using the following equation:

$$UTL = \bar{x} + (K \times s),$$

where  $\bar{x}$  is the sample mean;  
K is the tolerance factor; and  
s is the sample standard deviation.

Normal UTLs were calculated for a coverage of 95 percent (i.e., the 95th percentile) with 95 percent confidence.

For data sets that were not normally distributed, nonparametric UTLs are calculated. A nonparametric UTL is calculated by first ranking the concentrations and then choosing the lowest ranked detected concentration that provides a coverage of 95 percent with 95 percent

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confidence. For data sets with less than 59 concentrations, 95 percent coverage is not possible with 95 percent confidence even when the maximum concentration is assigned as the UTL. This was the case for the data sets in this evaluation so the estimated percentile (95<sup>th</sup> or lower) associated with the maximum concentration (assuming the magnitude of the maximum concentration appears defensible) was reported.

Regardless of the estimated percentile of a UTL, an elevated onsite result that exceeds this UTL does not prove that contamination above background levels is present. It is merely considered likely that an elevated onsite concentration represents contamination when it is higher than the estimate of an upper percentile (i.e. 95<sup>th</sup> percentile) of the background population. When the UTL represents an estimate of a relatively lower percentile (i.e. 79<sup>th</sup>), it becomes less rare for an onsite concentration to exceed the UTL even though the onsite population is essentially equivalent to background. This would be the case for arsenic (both dissolved and total metals) whose UTLs were calculated in a nonparametric fashion.

Since nonparametric UTLs can be highly influenced by the magnitude of a single result (the maximum), care was taken to insure that an extremely skewed value did not misrepresent the overall background population in the determination of the UTL. When the highest detected concentration for a given parameter was deemed indefensible (relative to the rest of the data set) to serve as the nonparametric UTL, this result was excluded from the calculation of a background UTL.

This occurred with iron and manganese. For both total and dissolved metal analysis, these parameters had elevated concentrations that could have served as nonparametric UTLs if they had not appeared so elevated. These elevated concentrations can be seen in Figure 2.

The concentrations removed from background UTL calculations include total iron concentrations of 30,100 ug/L and 13,900 ug/L, a dissolved iron concentration of 27,800 ug/L, a total manganese concentration of 1,680 ug/L, and a dissolved manganese concentration of 1,610 ug/L. After removal of these elevated concentrations, the resulting distributions for iron and manganese appeared normal, so normal UTLs were calculated with the remaining data. The calculated UTLs for arsenic, iron, and manganese are presented in Table 3 for both dissolved and total metals.

### **Summary Statistics**

The results excluded from the calculation of the background UTL are not excluded from the other summary statistics presented in Table 3, nor should they be excluded from central tendency comparisons potentially performed in the future with this background data set. The elevated iron and manganese concentrations are not so elevated that they appear unlikely to be a part of the background population. Central tendency comparisons use the entire background data set in the comparison, so the test is not particularly sensitive to a single elevated concentration. These concentrations are only excluded from the background UTL calculations so that these elevated values are not automatically chosen as the nonparametric UTL for their respective parameters.

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The other statistics estimated in Table 3 include the estimated percentile of the UTL (the target was the 95<sup>th</sup> percentile, but the nonparametric approaches resulted in some deviations from this as described previously). This table also presents the calculated mean, standard deviation, median, frequency of detects, minimum and maximum detected results (along with their associated validation flags) as well as the normality p-value obtained with the Shapiro-Wilk test.

A visual look at the distributional assumptions of the background is provided in the probability plots shown in Figure 3. Probability plots can be used to study the spread of concentrations in the data set while visually checking adherence of the data to the assumptions of normality (or another distributional assumption such as lognormality). When the measured results are plotted against the expected value from the respective distribution, a straight line is expected when the assumption is correct. These plots also provide a perspective on the range and skewness of the data. Since the background UTL is drawn on each plot, this set of plots provides still another visual presentation of where the UTL fits in the distribution of sample data.

Note that lognormal probability plots are included even though lognormality was not credibly considered as a suitable distributional assumption for this background data. A sample size of thirteen is small for defensible evaluation of lognormality, but inspection of the lognormality probability plots themselves can help one assess whether a data set with elevated values be considered a skewed distribution or evidence of two separate distributions (one made up of the lower concentrations and the other made up of the elevated outliers). From these plots it makes sense to consider the elevated concentrations, along with the other concentrations, part of a skewed distribution. This is consistent with the decision discussed earlier to not exclude these elevated concentrations from the background data set (e.g., for potential central tendency comparisons).

#### ***Statistical References***

Environmental Protection Agency (EPA). *Guidance for Data Quality Assessment. Practical Methods for Data Analysis*. Office of Research and Development, Washington, D.C. 1998.

Gilbert, Richard O. *Statistical Methods for Environmental Pollution Monitoring*. New York: Van Nostrand Reinhold Company, New York, 1987.

## **Future Use of Background Data**

The January and July background data sets will be combined (if appropriate) to evaluate SWMU-specific concentrations of inorganics in exceedance of comparison criteria at individual SWMUs. Background data, in general, does not reflect concentrations above the screening criteria for these selected metals. Consequently, it is unlikely that background data will be helpful in explaining SWMU specific risks associated with arsenic, iron, lead, and manganese.

Table 1  
Field Parameters  
NAS Oceana Background Wells  
January/July 2003

Station ID	MW-BG01		MW-BG02		MW-BG03		MW-BG04		MW-BG05		MW-BG06		MW-BG07	
Sample ID	MW-BG01-03A	MW-BG01-03C	MW-BG02-03A	MW-BG02-03C	MW-BG03-03A	MW-BG03-03C	MW-BG04-03A	MW-BG04-03C	MW-BG05-03A	MW-BG05-03C	MW-BG06-03A	MW-BG06-03C	MW-BG07-03A	MW-BG07-03C
Sample Date	1/20/2003	7/23/2003	1/20/2003	7/24/2003	1/20/2003	7/24/2003	1/20/2003	7/24/2003	1/21/2003	7/24/2003	1/21/2003	7/24/2003	1/21/2003	7/24/2003
Field Parameters														
Dissolved Oxygen (mg/L)	0	3.14	0	2.84	0	2.87	0	1.9	8.46	3.44	1.62	1.06	1.66	1.51
Depth to Water (ft)	5.81	6.6	6.88	4.66	7.13	6.02	5.19	3.39	8.97	7.35	6.19	3.85	5.75	4.4
Oxidation Reduction Potential (mV)	84	138	117	98	76	128	255	335	290	240	101	111	267	134
Flow Rate (GPM)	0.07	0.056	0.061	0.048	0.109	0.057	0.087	0.05	0.087	0.05	0.087	0.052	0.079	0.054
Gallons Purged (GAL)	NA	3.5	2.5	2	3	2	4	3	2	2	2	1.5	2	2.5
pH	5.75	5.4	5.06	4.53	6	5.46	4.71	3.97	5.35	4.82	5.13	4.67	4.74	5.13
Specific Conductance (ms/cm)	0.346	0.36	0.104	0.1	0.336	0.31	0.205	0.19	0.094	0.09	-141	0.12	0.146	0.18
Temperature (C)	15.07	17.3	14.51	19.4	12.32	19.8	13.41	19.67	10.79	22.1	14.38	19.1	15.04	18.94
Turbidity (NTU)	54.9	21	51.6	2	83.9	29	69.2	8	13	2	0	8	3.4	18.2

Notes:  
NA - Not analyzed

Table 1  
Field Parameters  
NAS Oceana Background Wells  
January/July 2003

MW-BG08		MW-BG09		MW-BG10		MW-BG11		MW-BG12		MW-BG13	
MW-BG08-03A	MW-BG08-03C	MW-BG09-03A	MW-BG09-03C	MW-BG10-03A	MW-BG10-03C	MW-BG11-03A	MW-BG11-03C	MW-BG12-03A	MW-BG12-03C	MW-BG13-03A	MW-BG13-03A
1/21/2003	7/24/2003	1/20/2003	7/24/2003	1/21/2003	7/24/2003	1/21/2003	7/24/2003	1/20/2003	7/23/2003	1/20/2003	
1.47	2	0	1.46	2.29	1.06	1.09	2.42	0	2.88	0	3.26
5.56	4.31	4.05	2.45	5.69	2.14	4.97	3.98	4.21	3.52	2.99	3.2
147	139	178	84	331	234	312	103	106	177	240	369
0.087	0.06	0.087	0.057	0.035	0.035	0.07	0.053	0.061	0.047	0.061	0.063
NA	2	2.9	2	NA	1	NA	2.5	3	4	NA	4
5.55	4.97	5.11	4.89	5.1	4.33	4.32	4.98	5.32	4.34	4.84	4.15
0.229	0.24	0.23	0.24	0.063	0.05	0.778	0.18	0.087	0.079	0.147	0.134
16.64	19.5	14.71	18.6	12	21.8	13.26	18.4	14.55	18.78	15.69	19.94
25	54	227	34	38.6	58	40	50	53.4	36	50	37

Table 2  
Metals Detect Data  
January/July 2003  
NAS Oceana Background Investigation

Station ID			MW-BG02		MW-BG03		MW-BG04		MW-BG05		MW-BG06		MW-BG07		MW-BG08	
Sample ID	MW-BG01-03A*	MW-BG01-03C	MW-BG02-03A	MW-BG02-03C	MW-BG03-03A	MW-BG03-03C	MW-BG04-03A	MW-BG04-03C	MW-BG05-03A	MW-BG05-03C*	MW-BG06-03A	MW-BG06-03C	MW-BG07-03A	MW-BG07-03C	MW-BG08-03A	MW-BG08-03C
Sample Date	01/20/03	07/23/03	01/20/03	07/24/03	01/20/03	07/24/03	01/20/03	07/24/03	01/21/03	07/24/03	01/21/03	07/24/03	01/21/03	07/24/03	01/21/03	07/24/03
Chemical Name																
Total Metals (UG/L)																
Arsenic	4.5 J	4.5 B	2 U	1.7 U	2 U	3.4 B	2 U	1.7 U	2 U	1.7 U	2.7 J	2.8 B	10.1	12.4	3.6 J	2 B
Iron	4,040 K	6,590	2,660 J	2,730	1,650 K	1,390	2,990 K	968	14.6 U	133 B	1,800 K	1,790	1,670 K	2,630	2,720 J	6,310
Manganese	165	164	63.6 J	60.3	61.6	69.3	101	79.5	4 B	6.8 J	42.3	34.7	69.7	42.5	251 J	210

Notes:  
 \*- Duplicate, most conservative value recorded  
 NA - Not analyzed  
 B - Analyte not detected above associated blank  
 J - Reported value is estimated  
 K - Reported value may be biased high  
 U - Analyte not detected

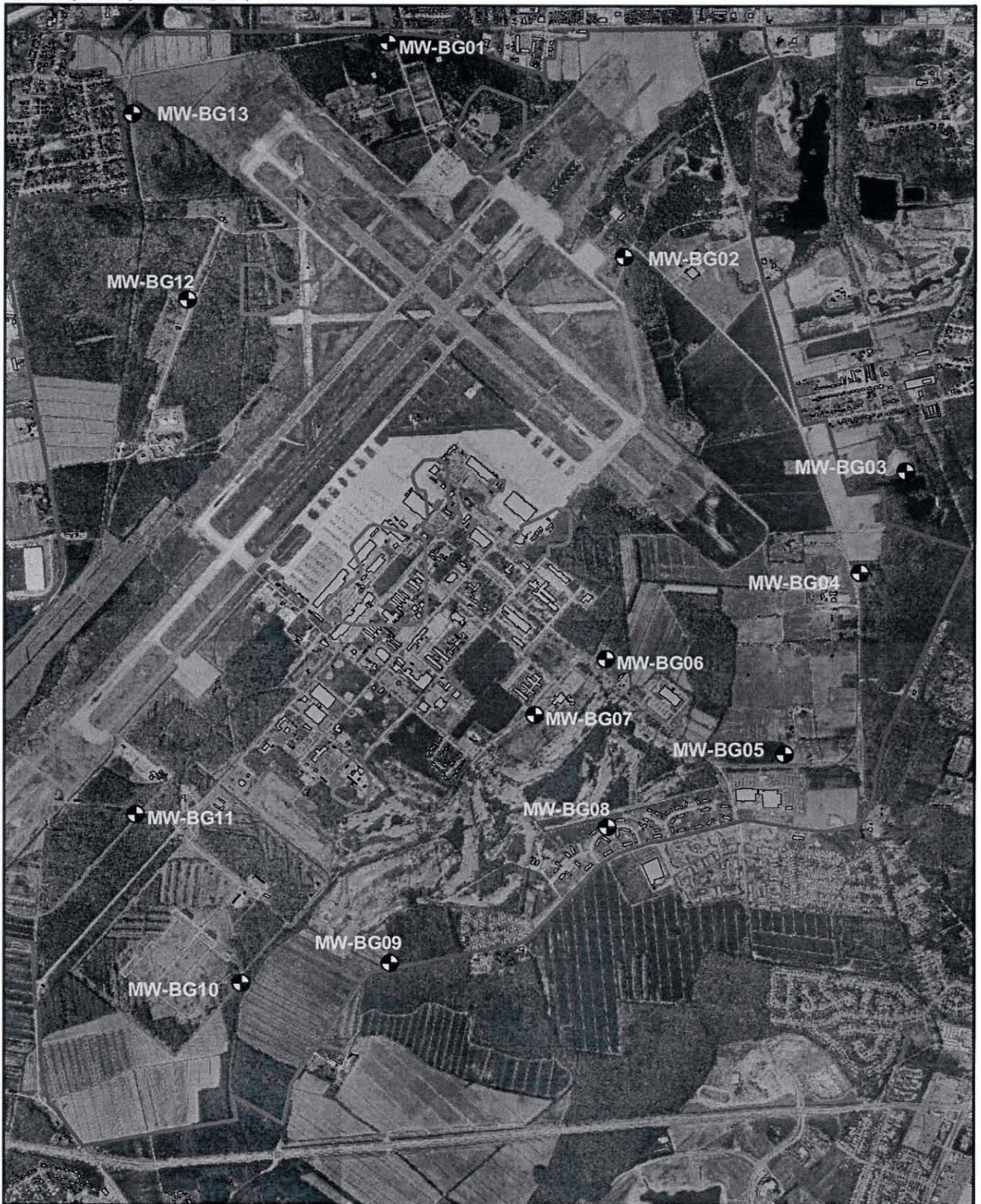
Table 2  
Metals Detect Data  
January/July 2003  
NAS Oceana Background Investigation

Station ID	MW-BG09		MW-BG10		MW-BG11		MW-BG12		MW-BG13	
Sample ID	MW-BG09-03A	MW-BG09-03C	MW-BG10-03A	MW-BG10-03C	MW-BG11-03A	MW-BG11-03C	MW-BG12-03A	MW-BG12-03C	MW-BG13-03A	MW-BG13-03C
Sample Date	01/20/03	07/24/03	01/21/03	07/24/03	01/21/03	07/24/03	01/20/03	07/23/03	01/20/03	07/23/03
Chemical Name										
Total Metals (UG/L)										
Arsenic	13.6	6.4 B	2 U	1.7 U	6.9 J	1.7 U	5.7 J	4.1 B	2 U	1.7 U
Iron	13,000 K	6,670	572 J	648	30,100 J	9,600	2,330 K	2,310	792 K	1,240
Manganese	156	141	12.5 J	15.6	1,680 J	221	47.7	37.1	167	36.5

Notes:  
 \* - Duplicate, most conservative value recorded  
 NA - Not analyzed  
 B - Analyte not detected above associated blank  
 J - Reported value is estimated  
 K - Reported value may be biased high  
 U - Analyte not detected

Table 3  
Summary Statistics for Background Parameters  
NAS Oceana  
Virginia Beach, Virginia

Parameter	Analysis Method	Background UTL	Assumed Distribution for UTL	Percentile Estimated	Mean	Median	Std Dev	Frequency of Detects	Minimum	Minimum Flag	Maximum	Maximum Flag	Normality p-value
Arsenic	Dissolved	8.1		89	2.38	1	2.08	12/27	1.8	B	8.1	J	3.35E-05
Iron	Dissolved	8140		89	2010	1530	1940	26/26	31.4	J	8140		2.03E-03
Manganese	Dissolved	250		89	87.9	64	72.7	26/26	5.6	J	250		1.01E-02
Arsenic	Total	13.8		89	3.51	2	3.65	14/27	2	B	13.8		2.52E-05
Iron	Total	9600		89	2590	1800	2390	24/25	125	B	9600		1.19E-03
Manganese	Total	251		89	88.9	66.5	74	26/26	4	B	251	J	9.82E-03



**LEGEND**

-  Monitoring Well Locations
-  SWMU Boundaries
-  Buildings
-  Roads
-  Runways
-  Activity Boundary Line

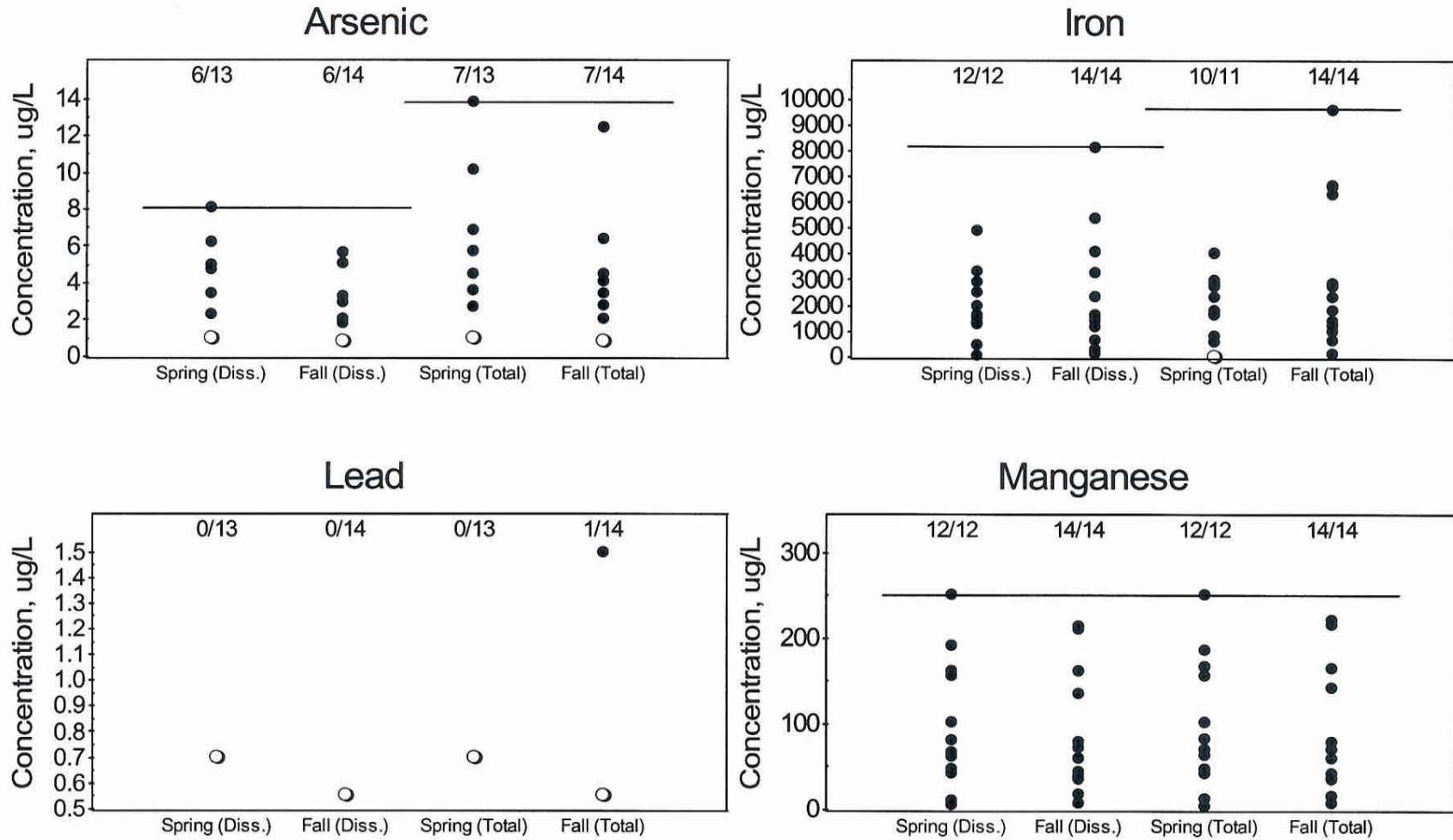


0 2000 4000 Feet

Figure 1  
Inorganic Background Monitoring Well Locations  
NAS Oceana  
Virginia Beach, Virginia

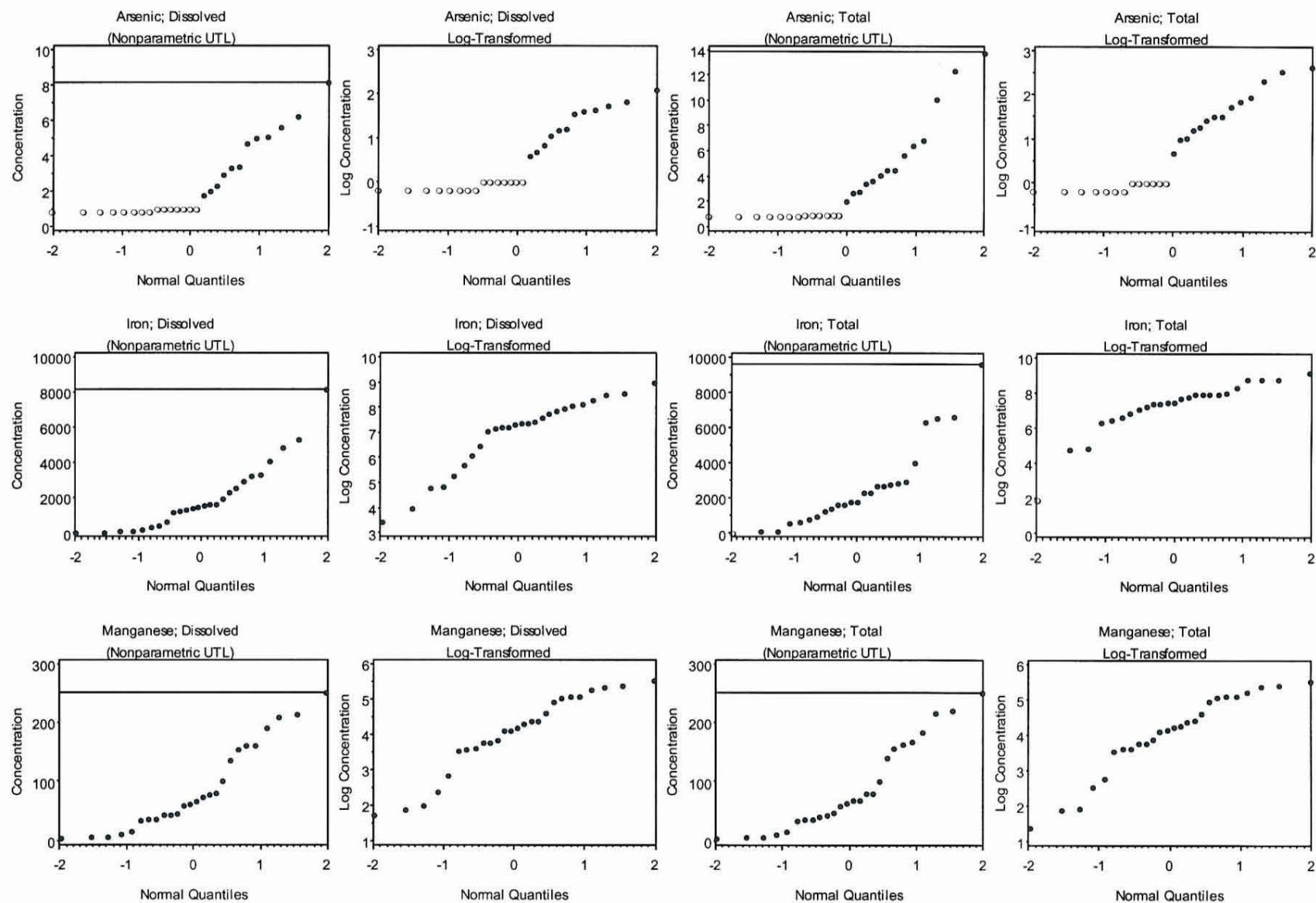
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Figure 2: Scatter Plots for Detected Parameters  
 NAS Oceana Background Investigation  
 Virginia Beach, VA

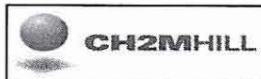


Open Symbol Represents Nondetected Value; Frequency of Detection Provided at Top of Plots  
 Horizontal Line Drawn at Calculated Background UTL

Figure 3: Probability Plots for Detected Parameters  
NAS Oceana Background Investigation  
Virginia Beach, VA



Open Symbol Represents Nondetected Value



PROJECT NUMBER <b>175094.FI.FK</b>	BORING NUMBER <b>MW-BG01</b>
SHEET 1 OF 1	
<h2 style="margin: 0;">SOIL BORING LOG</h2>	

PROJECT : CTO-267	DRILLING CONTRACTOR : Drill-Pro	LOCATION : NAS Oceana, VA
ELEVATION : n/a	NORTHING: 3473989.179	EASTING: 12205407.388
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger		
WATER LEVELS bgs	START : 01/06/03-0840	END : 01/06/03-0855    LOGGER : D. Blitzler

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)			STANDARD	CORE DESCRIPTION	COMMENTS
		RECOVERY (IN)		PENETRATION		
			#/TYPE	TEST		
				RESULTS		
				6"-6"-6"-6" (N)	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm):   Breathing Zone   Above Hole
5	5-7'	14	1		Sandy clay grading to a silty sand with depth; gray; moist; poorly sorted	
10	10-12'	12	2		Silty med. sand with 3" sandy clay lens; gray; wet; grading coarser with depth	
15	15-17'	12	3		Medium grained sand; gray; wet; loose; fining w/ depth	
20					Boring terminated at 18' bgs	
25						

## WELL COMPLETION DIAGRAM

PROJECT : CTO-267

LOCATION : NAS Oceana, VA

DRILLING CONTRACTOR :Drill-Pro

NORTHING: 3473989.179

EASTING: 12205407.388

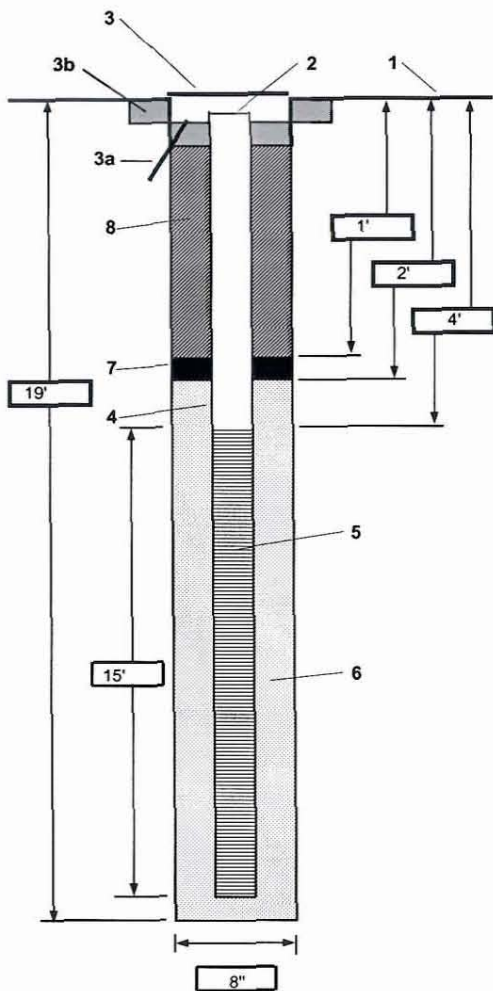
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger

WATER LEVELS: bgs

START : 01/06/03

END : 01/06/03

LOGGER : D. Blitzer

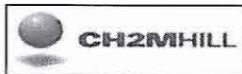




<b>PROJECT NUMBER</b> <b>175094.FI.FK</b>	<b>BORING NUMBER</b> <b>MW-BG02</b>	<b>SHEET 1 OF 1</b>
<h2 style="margin: 0;">SOIL BORING LOG</h2>		

PROJECT : CTO-267	DRILLING CONTRACTOR : Drill-Pro	LOCATION : NAS Oceana, VA
ELEVATION :	NORTHING: 3470258.345	EASTING: 12209410.94
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger		
WATER LEVELS bgs	START : 01/03/03-1029	END : 01/03/03-1043    LOGGER : P. Landin

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)			STANDARD	CORE DESCRIPTION	COMMENTS
		RECOVERY (IN)	#/TYPE	PENETRATION	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
				TEST RESULTS		
				6"-6"-6"-6" (N)		
						OVM (ppm): Breathing Zone Above Hole
5	5-7'	14	1		5-5.5'- Silty clay; brown; stiff; plastic 5.5-6.2'- Fine to med sand; tan to gray; wet; well-graded	
10	10-12'	14	2		5-5.5'- Sandy clay; light brown; wet; plastic 5.5-6.2'- Sandy silt, gray, wet; soft; grading to medium sand; gray; wet	
15	15-17'	12	3		Very fine sand with silt; gray; wet	Faint petroleum odor, no visible sheen or staining.
20					Boring terminated at 17' bgs	
25						



PROJECT NUMBER  
175094.FI.FK

WELL NUMBER  
MW-BG02

SHEET 1 OF 1

## WELL COMPLETION DIAGRAM

PROJECT : CTO-267

LOCATION : NAS Oceana, VA

DRILLING CONTRACTOR : Drill-Pro

NORTHING: 3470258.345

EASTING: 12209410.94

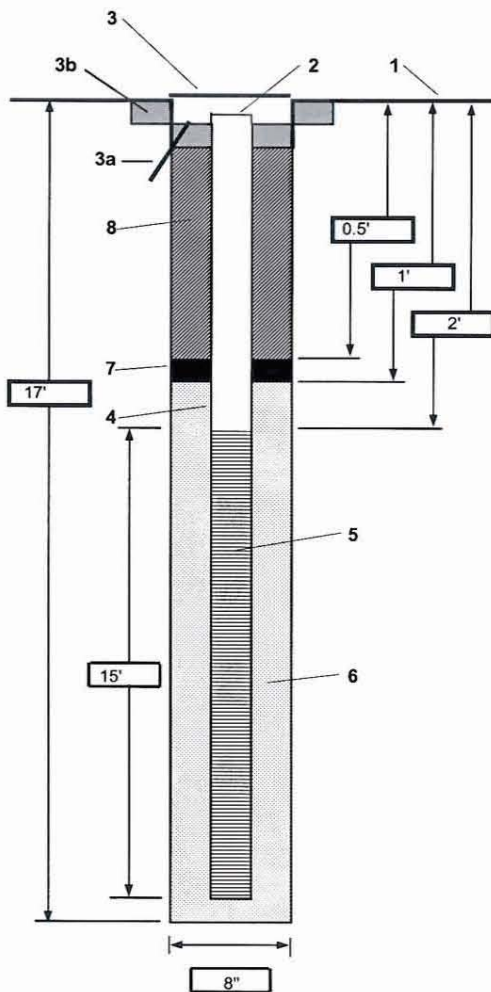
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger

WATER LEVELS : bgs

START : 01/03/03

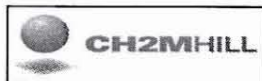
END : 01/03/03

LOGGER : P. Landin



1- Ground elevation at well	
2- Top of casing elevation	
3- Wellhead protection cover type	Stick-up casing
a) drain tube?	No
b) concrete pad dimensions	1' diam
4- Dia./type of well casing	2" PVC
5- Type/slot size of screen	.010 Slot
6- Type screen filter	#3 Well Gravel
a) Quantity used	6 bags
7- Type of seal	Baroid Bentonite Powder
a) Quantity used	1 bag
8- Grout	
a) Grout mix used	Concrete/Portland Cement
b) Method of placement	Shovel
c) Vol. of well casing grout	
Development method	Whale Pump
Development time	1.5 hrs
Estimated purge volume	80 gal

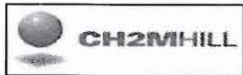
Comments Considerable time was needed to lower turbidity <20 NTU.



<b>PROJECT NUMBER</b> <b>175094.FI.FK</b>	<b>BORING NUMBER</b> <b>MW-BG03</b>	<b>SHEET 1 OF 1</b>
<h2 style="margin: 0;">SOIL BORING LOG</h2>		

PROJECT : CTO-267	DRILLING CONTRACTOR : Drill-Pro	LOCATION : NAS Oceana, VA
ELEVATION :	NORTHING: 3466496.975	EASTING: 12214141.11
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger		
WATER LEVELS bgs	START : 01/02/03-1430	END : 01/02/03-1505    LOGGER : P. Landin

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)			STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION  SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS  DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
	RECOVERY (IN)	#/TYPE	#/TYPE			
5	5-7'	18	1		5-5.5'-Clayey silt; dark brown; moist 5.5-6.5'- Medium sand; light brown; wet; poorly graded	
10	10-12'	24	2		Clayey sand; gray; wet; very soft; plastic	
15	15-17'	18	3		Fine to medium sand; gray; wet; poorly graded	
20					Boring terminated at 17' bgs	
25						



PROJECT NUMBER  
175094.FI.FK

WELL NUMBER

SHEET 1

OF 1

## WELL COMPLETION DIAGRAM

PROJECT : CTO-267

LOCATION : NAS Oceana, VA

DRILLING CONTRACTOR : Drill-Pro

NORTHING: 3466496.975

EASTING: 12214141.11

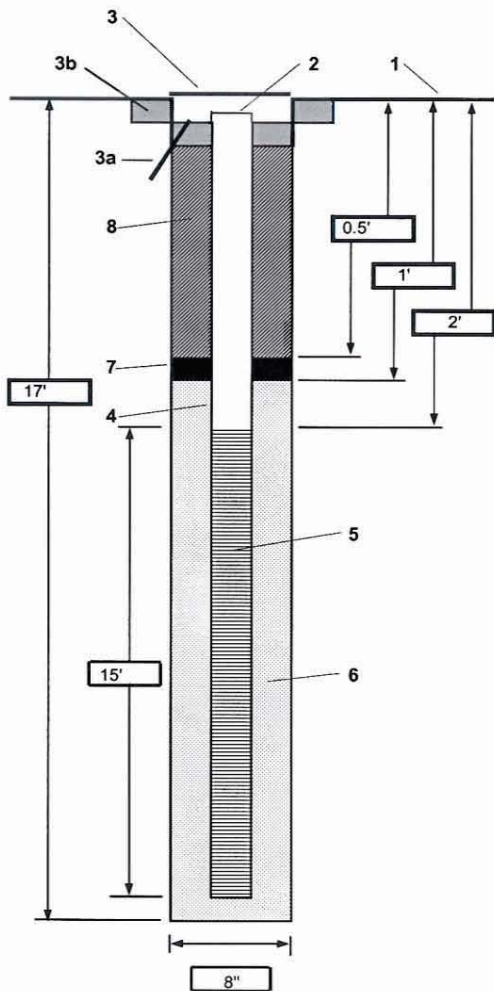
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger

WATER LEVELS : bgs

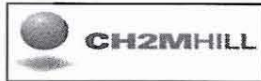
START : 01/02/03

END : 01/02/03

LOGGER : P. Landin



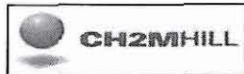
1- Ground elevation at well	
2- Top of casing elevation	
3- Wellhead protection cover type	Stick-up casing
a) drain tube?	No
b) concrete pad dimensions	1' diam
4- Dia./type of well casing	2" PVC
5- Type/slot size of screen	.010 Slot
6- Type screen filter	#3 Well Gravel
a) Quantity used	5 bags
7- Type of seal	Baroid Bentonite Powder
a) Quantity used	1/2 bag
8- Grout	
a) Grout mix used	Concrete/Portland Cement
b) Method of placement	Shovel
c) Vol. of well casing grout	
Development method	Whale Pump
Development time	38 mins
Estimated purge volume	60 gal
Comments	



PROJECT NUMBER <b>175094.FI.FK</b>	BORING NUMBER <b>MW-BG04</b>	SHEET 1 OF 1
<b>SOIL BORING LOG</b>		

PROJECT : CTO-267	DRILLING CONTRACTOR : Drill-Pro	LOCATION : NAS Oceana, VA
ELEVATION :	NORTHING: 3464722.26	EASTING: 12213382.724
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger		
WATER LEVELS bgs	START : 01/03/03-0845	END : 01/03/03-0900
LOGGER : P.Landin		

DEPTH BELOW SURFACE (FT)				STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION  SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS  DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
	INTERVAL (FT)	RECOVERY (IN)				
		#/TYPE				
5	5-7'	16	1		Sandy clay grading to a fine medium sand; brown; wet; poorly graded with a decrease in consistency from top to bottom	
10	10-12'	18	2		Fine sand; tan to light brown; very wet; poorly graded	
15	15-17'	24	3		15-15.5'-Run-up in augur of sandy peat; organic 15.5-17'- Silty clay; gray; wet; soft	
20					Boring terminated at 20' bgs	
25						



PROJECT NUMBER  
175094.FI.FK

WELL NUMBER  
MW-BG04

SHEET 1 OF 1

## WELL COMPLETION DIAGRAM

PROJECT : CTO-267

LOCATION : NAS Oceana, VA

DRILLING CONTRACTOR : Drill-Pro

NORTHING: 3464722.26

EASTING: 12213382.724

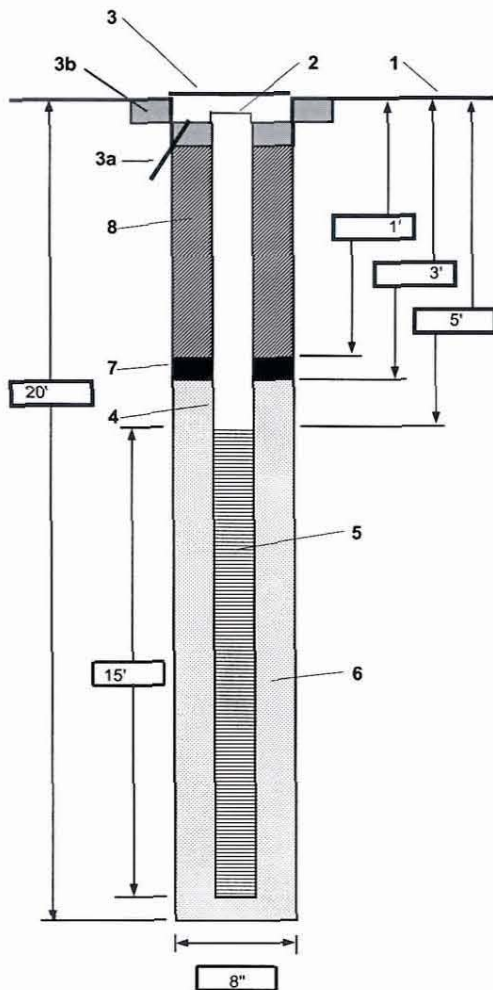
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger

WATER LEVELS : bgs

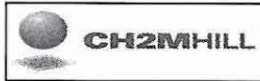
START : 01/03/03

END : 01/03/03

LOGGER : P. Landin



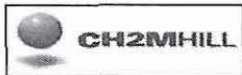
- 1- Ground elevation at well \_\_\_\_\_
- 2- Top of casing elevation \_\_\_\_\_
- 3- Wellhead protection cover type Flush Mount
- a) drain tube? No
- b) concrete pad dimensions 1' diam
- 4- Dia./type of well casing 2" PVC
- 5- Type/slot size of screen .010 Slot
- 6- Type screen filter #3 Well Gravel
- a) Quantity used 7 bags
- 7- Type of seal Baroid Bentonite Powder
- a) Quantity used 1 bag
- 8- Grout Concrete/Portland Cement
- a) Grout mix used Shovel
- b) Method of placement \_\_\_\_\_
- c) Vol. of well casing grout \_\_\_\_\_
- Development method Whale Pump
- Development time 55 min
- Estimated purge volume 65 gal
- Comments \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_



<b>PROJECT NUMBER</b> <b>175094.FI.FK</b>	<b>BORING NUMBER</b> <b>MW-BG05</b>	<b>SHEET 1 OF 1</b>
<h2 style="margin: 0;">SOIL BORING LOG</h2>		

PROJECT : CTO-267	DRILLING CONTRACTOR : Drill-Pro	LOCATION : NAS Oceana, VA
ELEVATION :	NORTHING: 3461556.363	EASTING: 12212125.046
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger		
WATER LEVELS bgs	START :01/03/03-1600	END : 01/03/03-1615    LOGGER :P. Landin

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)		STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION  SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS  DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
		RECOVERY (IN)			
		#/TYPE			
5	5-7'	16	1	5-5.25-Sandy silt; dark brown; wet 5.25-6.25-Fine to medium sand; dark brown; wet	
10	10-12'	20	2	Top 4"-Fine to medium sand; dark brown; wet Bottom 16"- Clay; gray; wet; very soft; plastic	
15	15-17'	18	3	Fine sand; gray; wet; poorly graded	
20				Boring Terminated at 18' bgs	
25					



PROJECT NUMBER  
175094.FI.FK

WELL NUMBER  
MW-BG05

SHEET 1 OF 1

## WELL COMPLETION DIAGRAM

PROJECT : CTO-267

LOCATION : NAS Oceana, VA

DRILLING CONTRACTOR : Drill-Pro

NORTHING: 3461556.363

EASTING: 12212125.046

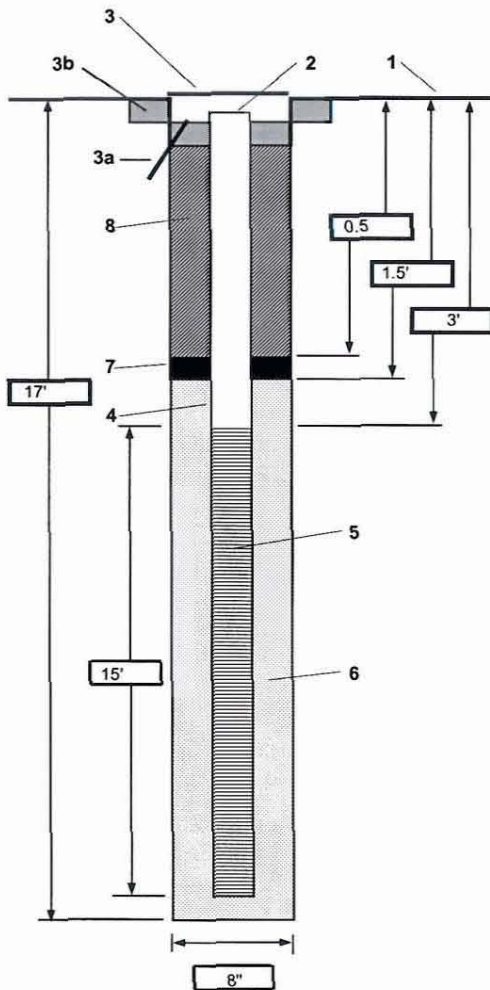
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger

WATER LEVELS : bgs

START : 01/03/03

END : 01/03/03

LOGGER : P. Landin



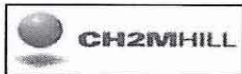
1- Ground elevation at well	
2- Top of casing elevation	
3- Wellhead protection cover type	Stick-up casing
a) drain tube?	No
b) concrete pad dimensions	1' diam
4- Dia./type of well casing	2" PVC
5- Type/slot size of screen	.010 Slot
6- Type screen filter	#3 Well Gravel
a) Quantity used	6 bags
7- Type of seal	Baroid Bentonite Powder
a) Quantity used	1 bag
8- Grout	
a) Grout mix used	Concrete/Portland Cement
b) Method of placement	Shovel
c) Vol. of well casing grout	
Development method	Whale Pump
Development time	1.5 hrs
Estimated purge volume	60 gal
Comments	



<b>PROJECT NUMBER</b> <b>175094.FI.FK</b>	<b>BORING NUMBER</b> <b>MW-BG06</b>
<b>SHEET 1 OF 1</b>	
<h2 style="margin: 0;">SOIL BORING LOG</h2>	

PROJECT : CTO-267	DRILLING CONTRACTOR : Drill-Pro	LOCATION : NAS Oceana, VA
ELEVATION :	NORTHING: 3463218.225	EASTING: 12209115.987
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger		
WATER LEVELS bgs	START :01/06/03-1303	END : 01/06/03-1320    LOGGER : D.Blitzer

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
5	5-7'	15	1		5-5.5' - Topsoil (drill plug) 5.5-6.5'- Silty clay grading to a medium sand; gray; sand is well sorted	
10	10-12'	12	2		Medium sand with 2" sandy clay lens; gray; well sorted	
15	15-17'	4	3		Sandy clay; gray; wet; very soft; poorly sorted	
20					Boring Terminated at 18' bgs	
25						



PROJECT NUMBER  
175094.FI.FK

WELL NUMBER  
MW-BG06

SHEET 1 OF 1

## WELL COMPLETION DIAGRAM

PROJECT : CTO-267

LOCATION : NAS Oceana, VA

DRILLING CONTRACTOR : Drill-Pro

NORTHING: 3463218.225

EASTING: 12209115.987

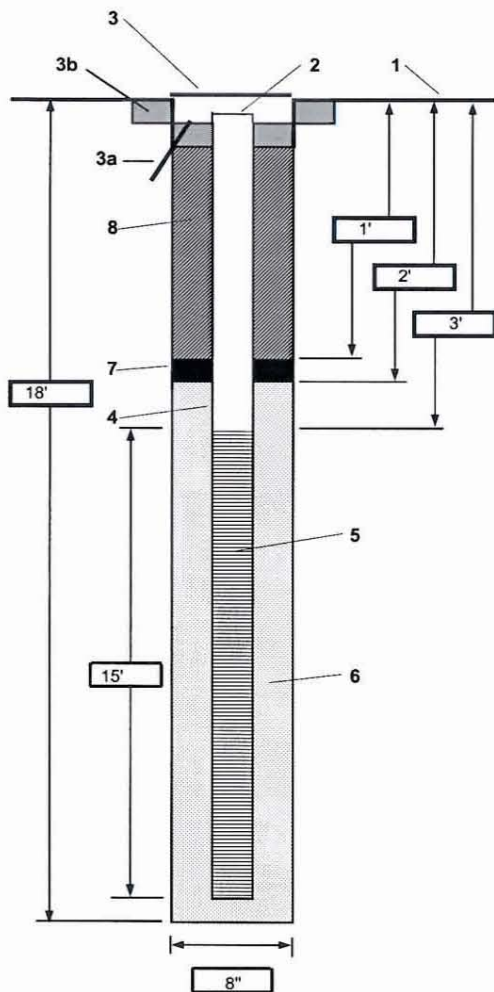
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger

WATER LEVELS : bgs

START : 01/06/03

END : 01/06/03

LOGGER : D. Blitzler



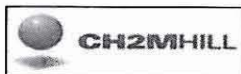
1- Ground elevation at well	
2- Top of casing elevation	
3- Wellhead protection cover type	Stick-up casing
a) drain tube?	No
b) concrete pad dimensions	1' diam
4- Dia./type of well casing	2" PVC
5- Type/slot size of screen	.010 Slot
6- Type screen filter	#3 Well Gravel
a) Quantity used	6 bags
7- Type of seal	Baroid Bentonite Powder
a) Quantity used	1 bag
8- Grout	
a) Grout mix used	Concrete/Portland Cement
b) Method of placement	Shovel
c) Vol. of well casing grout	
Development method	Whale Pump
Development time	1.5 hr
Estimated purge volume	75 gal
Comments	



<b>PROJECT NUMBER</b> <b>175094.FI.FK</b>	<b>BORING NUMBER</b> <b>MW-BG07</b>
SHEET 1 OF 1	
<h2 style="margin: 0;">SOIL BORING LOG</h2>	

PROJECT : CTO-267	DRILLING CONTRACTOR : Drill-Pro	LOCATION : NAS Oceana, VA
ELEVATION :	NORTHING:3462236.317	EASTING: 12207913.74
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger		
WATER LEVELS bgs	START : 01/07/03-1155	END : 01/07/03-1210    LOGGER : D. Blitzler

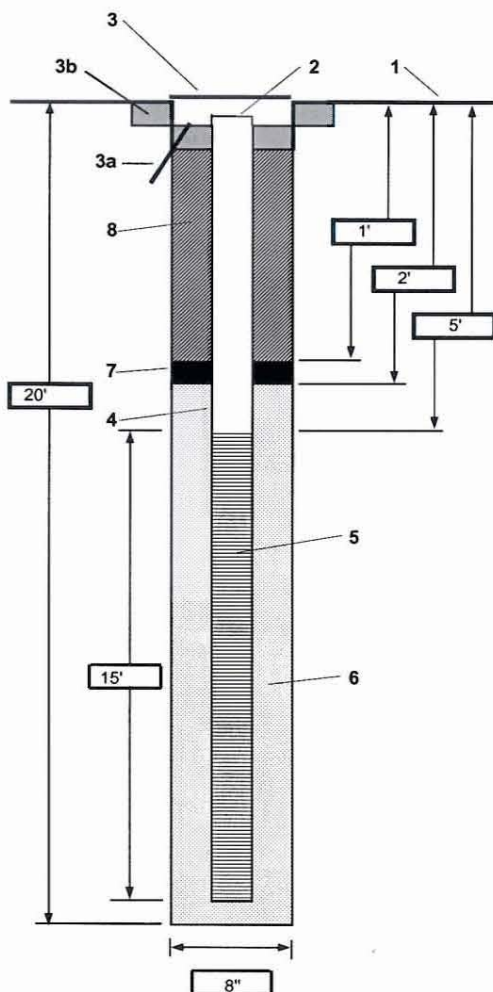
DEPTH BELOW SURFACE (FT)	INTERVAL (FT)			STANDARD	CORE DESCRIPTION	COMMENTS
		RECOVERY (IN)		PENETRATION	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
		#/TYPE	TEST	6"-6"-6"-6" (N)		
			RESULTS			
						OVM (ppm): Breathing Zone Above Hole
5	5-7'	12	1		0-6"-Silty clay topsoil grading to a silty sand; dark to orange brown; moist; soft 6-12"- Medium clean sand; reddish brown; moist loose	Notably different from all previous sands Possibly fill material
10	10-12'	20	2		Medium grained sand with trace silt; gray; wet; dense; fining downward	Similar to sands seen at previous borings
15	15-17'	12	3		Fine to medium grained clean sand; gray; wet; dense	
20					Boring terminated at 20' bgs	
25						



<b>PROJECT NUMBER</b> <b>175094.FI.FK</b>	<b>WELL NUMBER</b> <b>MW-BG07</b>
SHEET 1 OF 1	

## WELL COMPLETION DIAGRAM

PROJECT : CTO-267	LOCATION : NAS Oceana, VA	
DRILLING CONTRACTOR : Drill-Pro	NORTHING: 3462236.317	EASTING: 12207913.74
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger		
WATER LEVELS : bgs	START : 01/07/03	END : 01/07/03      LOGGER : D. Blitzler



1- Ground elevation at well	
2- Top of casing elevation	
3- Wellhead protection cover type	Flush Mount
a) drain tube?	No
b) concrete pad dimensions	1' diam
4- Dia./type of well casing	2" PVC
5- Type/slot size of screen	.010 Slot
6- Type screen filter	#3 Well Gravel
a) Quantity used	7 bags
7- Type of seal	Baroid Bentonite Powder
a) Quantity used	1 bag
8- Grout	
a) Grout mix used	Concrete/Portland Cement
b) Method of placement	Shovel
c) Vol. of well casing grout	
Development method	Whale Pump
Development time	59 mins
Estimated purge volume	60 gal

Comments \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

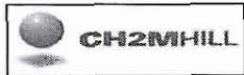
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<b>PROJECT NUMBER</b> <b>175094.FI.FK</b>	<b>BORING NUMBER</b> <b>MW-BG08</b>
<b>SHEET 1 OF 1</b>	
<b>SOIL BORING LOG</b>	

PROJECT : CTO-267	DRILLING CONTRACTOR : Drill-Pro	LOCATION : NAS Oceana, VA
ELEVATION :	NORTHING: 3460277.457	EASTING: 12209140.83
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger		
WATER LEVELS bgs	START :01/03/03-1417	END :01/03/03-1445    LOGGER :P. Landin

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)			STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION  SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS  DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.  OVM (ppm):    Breathing Zone    Above Hole
	RECOVERY (IN)	#/TYPE				
5	5-7'	16	1		Top 3"-Topsoil (May have been caught in augur) 3-16"- Fine to medium sand; tan to light brown; grading coarser with depth	
10	10-12'	12	2		Very fine sand; light brown to gray; wet	
15	15-17'	12	3		Same as above, no gray	
20					Boring terminated at 20' bgs	
25						



PROJECT NUMBER  
175094.FI.FK

WELL NUMBER  
MW-BG08

SHEET 1 OF 1

## WELL COMPLETION DIAGRAM

PROJECT : CTO-267

LOCATION : NAS Oceana, VA

DRILLING CONTRACTOR : Drill-Pro

NORTHING: 3460277.457

EASTING: 12209140.83

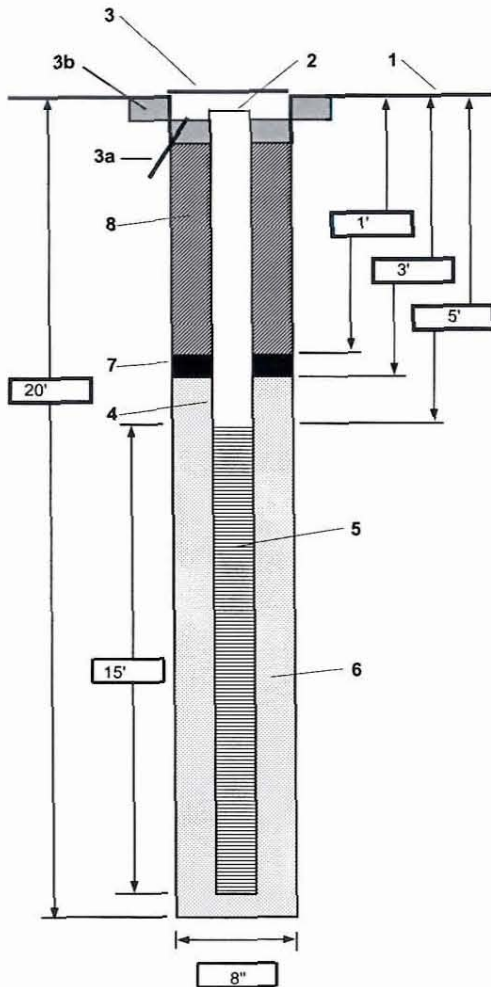
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger

WATER LEVELS : bgs

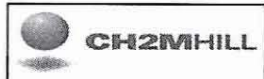
START : 01/03/03

END : 01/03/03

LOGGER : P. Landin



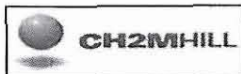
1- Ground elevation at well	
2- Top of casing elevation	
3- Wellhead protection cover type	Flush Mount
a) drain tube?	No
b) concrete pad dimensions	1' diam
4- Dia./type of well casing	2" PVC
5- Type/slot size of screen	.010 Slot
6- Type screen filter	#3 Well Gravel
a) Quantity used	6 bags
7- Type of seal	Baroid Bentonite Powder
a) Quantity used	1 bag
8- Grout	
a) Grout mix used	Concrete/Portland Cement
b) Method of placement	Shovel
c) Vol. of well casing grout	
Development method	Whale Pump
Development time	33 min
Estimated purge volume	65 gal
Comments	



<b>PROJECT NUMBER</b> <b>175094.FI.FK</b>	<b>BORING NUMBER</b> <b>MW-BG09</b>
SHEET 1 OF 1	
<b>SOIL BORING LOG</b>	

PROJECT : CTO-267	DRILLING CONTRACTOR : Drill-Pro	LOCATION : NAS Oceana, VA
ELEVATION :	NORTHING: 3457884.306	EASTING: 12205477.876
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger		
WATER LEVELS bgs	START : 01/06/03-1010	END : 01/06/03-1023    LOGGER : D. Blitzer

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)		STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION  SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS  DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.  OVM (ppm): Breathing Zone    Above Hole
		RECOVERY (IN)			
		#/TYPE			
5	5-7'	12	1	Sandy clay; gray; moist; grading to a medium sand with some silt at bottom	
10	10-12'	18	2	Clean medium sand; gray; wet; well sorted	
15	15-17'	24	3	Medium sand grading into a finer sandy clay; gray; wet	
20				Boring terminated at 18' bgs	
25					



PROJECT NUMBER  
175094.FI.FK

WELL NUMBER  
MW-BG09

SHEET 1 OF 1

## WELL COMPLETION DIAGRAM

PROJECT : CTO-267

LOCATION : NAS Oceana, VA

DRILLING CONTRACTOR : Drill-Pro

NORTHING: 3457884.306

EASTING: 12205477.876

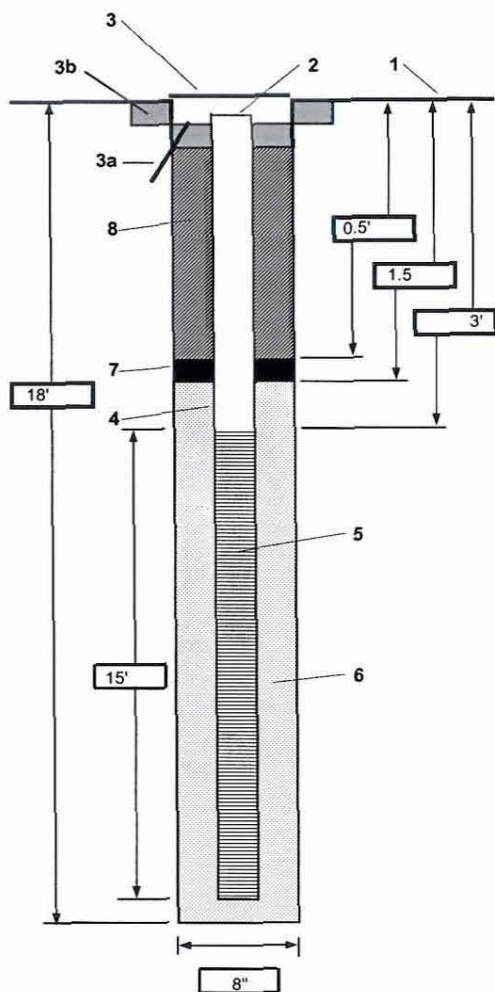
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger

WATER LEVELS : bgs

START : 01/06/03

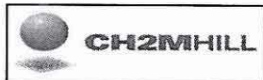
END : 01/06/03

LOGGER : D. Blitzer



1- Ground elevation at well	
2- Top of casing elevation	
3- Wellhead protection cover type	Stick-up casing
a) drain tube?	No
b) concrete pad dimensions	1' diam
4- Dia./type of well casing	2" PVC
5- Type/slot size of screen	.010 Slot
6- Type screen filter	#3 Well Gravel
a) Quantity used	6.5 bags
7- Type of seal	Baroid Bentonite Powder
a) Quantity used	1 bag
8- Grout	
a) Grout mix used	Concrete/Portland Cement
b) Method of placement	Shovel
c) Vol. of well casing grout	
Development method	Whale Pump
Development time	40 min
Estimated purge volume	60 gal

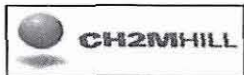
Comments



<b>PROJECT NUMBER</b> <b>175094.FI.FK</b>	<b>BORING NUMBER</b> <b>MW-BG10</b>
SHEET 1 OF 1	
<b>SOIL BORING LOG</b>	

PROJECT : CTO-267	DRILLING CONTRACTOR : Drill-Pro	LOCATION : NAS Oceana, VA
ELEVATION :	NORTHING: 3457532.263	EASTING: 12202959.848
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger		
WATER LEVELS bgs	START : 01/06/03-1430	END : 01/06/03-1444    LOGGER : D. Blitzler

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)			STANDARD	CORE DESCRIPTION	COMMENTS
	INTERVAL (FT)	RECOVERY (IN)		PENETRATION	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
		#/TYPE	TEST	6"-6"-6"-6" (N)		
			RESULTS			
						OVM (ppm): Breathing Zone Above Hole
5	5-7'	14	1		0-7"-Topsoil; dark brown silt; moist; organic 7-14'-Silty medium sand grading to medium clean sand; gleying and oxidation noted below 5.6'; wet	
10	10-12'	24	2		0-3"- Silty clay; brown; wet; soft 3-20"- Sandy clay; gray; wet; soft 20-24"- Medium grained clean sand; gray; wet; well sorted	
15	15-17'	24	3		Silty clay; gray; moist; stiff	
20					Boring terminated at 18' bgs	
25						



PROJECT NUMBER  
175094.FI.FK

WELL NUMBER  
MW-BG10

SHEET 1 OF 1

## WELL COMPLETION DIAGRAM

PROJECT : CTO-267

LOCATION : NAS Oceana, VA

DRILLING CONTRACTOR : Drill-Pro

NORTHING: 3457532.263

EASTING: 12202959.848

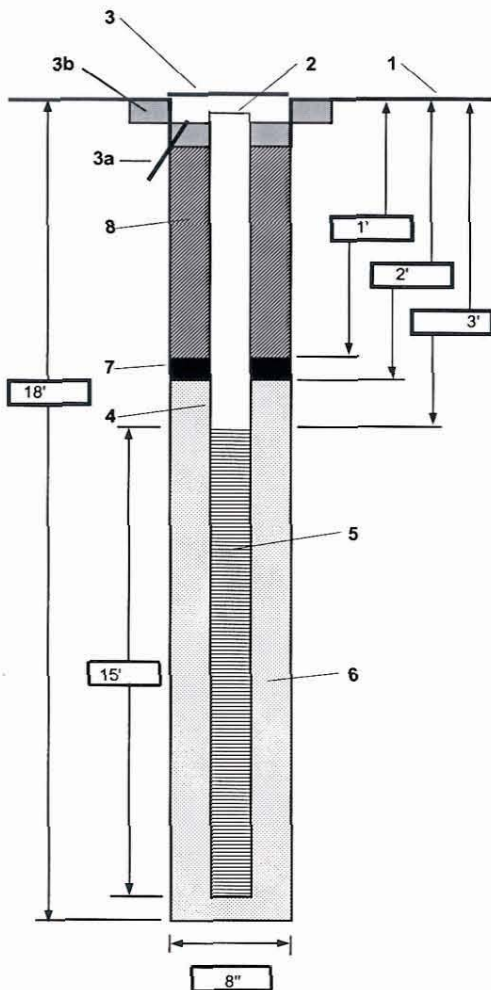
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger

WATER LEVELS : bgs

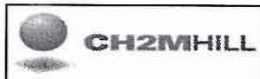
START : 01/06/03

END : 01/06/03

LOGGER : D. Blitzer



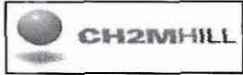
1- Ground elevation at well	
2- Top of casing elevation	
3- Wellhead protection cover type	Stick-up casing
a) drain tube?	No
b) concrete pad dimensions	1' diam
4- Dia./type of well casing	2" PVC
5- Type/slot size of screen	.010 Slot
6- Type screen filter	#3 Well Gravel
a) Quantity used	6 bags
7- Type of seal	Baroid Bentonite Powder
a) Quantity used	1/2 bag
8- Grout	
a) Grout mix used	Concrete/Portland Cement
b) Method of placement	Shovel
c) Vol. of well casing grout	
Development method	Whale Pump
Development time	3 hours
Estimated purge volume	46 gals
Comments	Well did not recharge fast enough to allow continuous development purging.



<b>PROJECT NUMBER</b> <b>175094.FI.FK</b>	<b>BORING NUMBER</b> <b>MW-BG11</b>
SHEET 1 OF 1	
<h2 style="margin: 0;">SOIL BORING LOG</h2>	

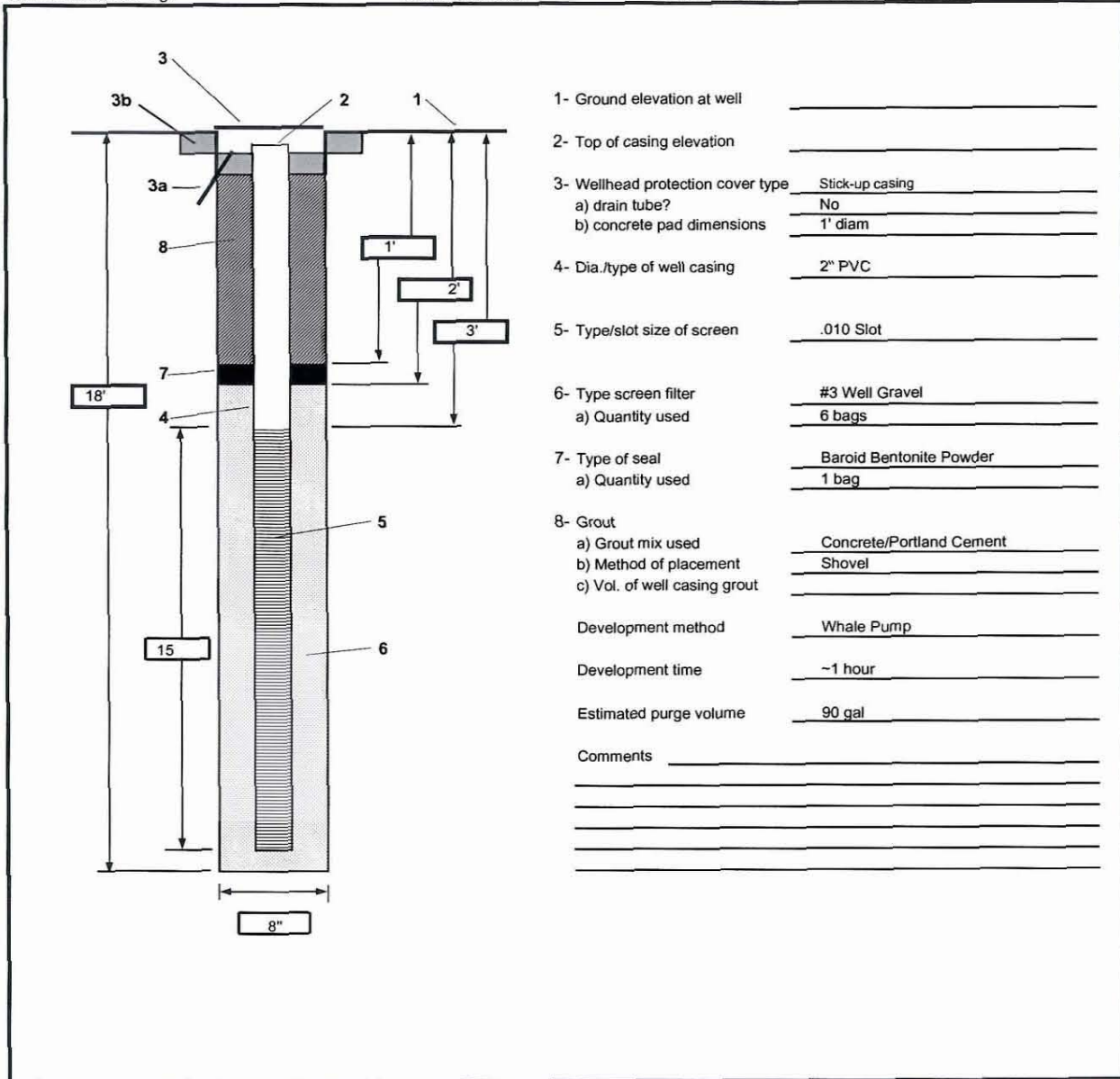
PROJECT : CTO-267	DRILLING CONTRACTOR : Drill-Pro	LOCATION : NAS Oceana, VA
ELEVATION :	NORTHING: 3460476.586	EASTING: 12201198.921
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger		
WATER LEVELS bgs	START : 01/06/03-1555	END : 01/06/03-1610    LOGGER : D. Blitzler

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)			STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION  SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS  DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm):    Breathing Zone    Above Hole
	RECOVERY (IN)					
	#/TYPE					
5	5-7'	5	1		Sandy silt; dark brown at top, oxidation towards bottom; moist; medium dense	
10	10-12'	24	2		Fine to medium clean sand; gray; wet; small lens of light brown sandy silt towards bottom; well sorted	
15	15-17'	4	3		Medium grained sand; gray; wet; loose; well sorted	
20					Boring terminated at 18' bgs	
25						



PROJECT NUMBER <b>175094.FI.FK</b>	WELL NUMBER <b>MW-BG11</b>	SHEET 1 OF 1
<h2 style="margin: 0;">WELL COMPLETION DIAGRAM</h2>		

PROJECT : CTO-267	LOCATION : NAS Oceana, VA	
DRILLING CONTRACTOR : Drill-Pro	NORTHING: 3460476.586	EASTING: 12201198.921
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger		
WATER LEVELS : bgs	START : 01/06/03	END : 01/06/03      LOGGER : D. Blitzler



## Reisch, Timothy A CIV NAVFAC MID ATLANTIC

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**From:** Reisch, Timothy A CIV NAVFAC MID ATLANTIC  
**Sent:** Tuesday, March 21, 2006 12:38 PM  
**To:** Host, Mike M CIV 106.3, C106.3; Nielsen, Janice L CIV 106.3, C106.3; Clifford, Peter J CIV 106.3, C106.3; Reisch, Timothy A CIV NAVFAC MID ATLANTIC; Debra Miller (damiller@deq.state.va.us); Franklin. Greyson (Franklin.Greyson@epamail.epa.gov); Paul/VBO' 'Landin (plandin@CH2M.com); Daniel. Holloway (Daniel.Holloway@CH2M.com)  
**Subject:** SITE 17 ROD; EPA-ORC RTC  
**Attachments:** Draft ROD RTC - ORC.pdf

TEAM,

As discussed this morning - attached are the responses to EPA-ORC comments.



Draft ROD RTC -  
ORC.pdf (178 K...

v/r

Timothy A. Reisch, P.E.  
Senior Remedial Project Manager  
NAVFAC MidAtlantic  
9742 Maryland Ave.  
Norfolk, VA 23511  
(757) 444-6890  
timothy.reisch@navy.mil

MEMORANDUM

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**Response to EPA-ORC Comments on *Draft Record of Decision for Site 17: Building 195-Plating Shop, Norfolk Naval Shipyard, Portsmouth, Virginia* (CH2M HILL, January 2006)**

TO: EPA-ORC

COPIES: CH2M HILL

FROM: Naval Facilities Engineering Command Mid-Atlantic

DATE: March 20, 2006

This memorandum compiles the Navy's responses to the EPA-ORC comments received on the *Draft Record of Decision for Site 17: Building 195 – Plating Shop, Norfolk Naval Shipyard, Portsmouth, Virginia* (CH2M HILL, January 2006). Thirty two specific comments were inserted into the electronic file reviewed by EPA-ORC and received by the Navy on Friday, March 10, 2006. Each of the specific comments has been reproduced below followed by the Navy's response in bold type. In addition to providing the following responses, the Navy acknowledges and accepts the editorial comments provided by the EPA-ORC. A copy of the "red-line" edited version of the Site 17 ROD will be placed into the Administrative Record for the site to provide documentation of these comments/revisions.

1. Unrestricted use/unlimited exposure is not restricted to residential use only. Also, my understanding is that risk in the residential use scenario is presumed, not quantified. So HHRA would have to be performed before LUCs could be discontinued.

**The Navy concurs with this comment and the redline changes are accepted in first sentence of the third paragraph in Section 1.4.**

2. A semi-colon is used to separate two independent clauses or to separate a series when one or more of the elements of the series itself includes a comma (the "strong comma" use of semicolon). Neither situation is presented in this sentence.

**The Navy concurs with this comment and the redline changes are accepted in the second to last sentence of the third paragraph in Section 1.4.**

3. Do you have to use the acronym CIA? RODs are public documents. CIA means something different to most people. If it's a very commonly used acronym at NNSY (everyone knows what it means and refers to that area solely as the "CIA") and every figure uses "the CIA" to denote that location, then I guess okay. Otherwise, I really recommend just using the words and no acronym.

**The CIA is an inherent term at NNSY. The RAB is familiar with this term and it is used and understood in text and conversation. The Navy prefers to use the acronym CIA for the controlled industrial area.**

4. Redundant. # means No.

**The Navy concurs with this comment and the redline changes are accepted.**

5. Unclear. Building 195 *houses* (?) a newer building addition?? A building inside a building?

**Section 2.1 has been revised to clarify the changes made to Building 195 – Plating Shop.**

**“Site 17, Building 195 – Plating Shop, is located in the CIA of NNSY (Figure 1). The NNSY is located off Effingham Street in the City of Portsmouth, Virginia. Building 195 – Plating Shop is a brick building that houses the plating area and a newer addition used for nonplating storage. The newer addition previously contained a trailer that supported the plating operations. The area surrounding Building 195 – Plating Shop is concrete and asphalt. Topography is flat at an elevation between 8 and 10 feet above mean sea level.”**

6. Redundant. “Potential” and “may” mean the same idea.

**The Navy concurs with this comment and the redline changes are accepted in the second paragraph of Section 2.2.1.**

7. Is this correct? If not, explain what’s going on with the other five sites.

**The second paragraph of Section 2.2 has been revised to include the five sites still under review at Operable Unit 2 (Sites 3 through 7).**

8. Surface water runoff flows into catch basins that connect to the NNSY stormwater system, which discharges into the Southern Branch of the Elizabeth River. Right?

**The Navy concurs with this comment and the redline changes are accepted in the last sentence of the second paragraph in Section 2.5.**

9. What’s the logic of bolding the table references but not the figure references??

**The bold text referencing tables has been removed throughout the document.**

10. Please change to either chemicals of concern (COCs) or chemicals of potential concern (COPCs), whichever is correct.

**The first sentence of the first paragraph of Section 2.5.3 has been edited to read: “chemicals of concern” rather than “chemical concentrations of concern.”**

11. Correct? Shouldn't this be written the opposite way? Site concentrations don't exceed MCLs. Pls. check.

**The last sentence of the first paragraph of Section 2.5.3 has been revised to state that no site mean concentrations for inorganics exceed MCLs.**

12. How are soils 8 inches bgs categorized? Adjust definitions to include soils between 6 and 12 inches. Were no samples taken at that depth?

**The sample approach at Site 17 was jointly scoped by the PMT with technical support/review from the EPA toxicologist. The PMT accepted the approach to develop a human health risk assessment based upon these sample depths and locations.**

13. The max concentrations will mean nothing to the reader without a corresponding action level of some sort. I recommend putting the numerical information into a table that also includes a column for RBCs.

**The bulleted list of COPCs in surface and subsurface soil has been removed from the document and the following sentence has been added to the second paragraph of Section 2.5.3 to include an action level:**

**"Table 2 presents a summary of the surface soil COPCs for the current and future onsite industrial worker receptor; surface soil, subsurface soil, and groundwater COPCs for the current and future construction worker receptor; and the groundwater COPC screening process for the future residential receptor."**

14. Will mean nothing to the reader. Hex chromium is more toxic than most other chromium, isn't it?

**The first sentence of the last paragraph of Section 2.5.3 has been revised to read:**

**"Hexavalent chromium, a more toxic form of chromium, was detected in subsurface soil beneath Building 195 – Plating Shop at concentrations that are one to two orders of magnitude less than corresponding total chromium concentrations."**

15. Is this correct? If not, then I don't understand the logic of the sentence after "therefore."

**The text "immediately" has been replaced with "1,875 feet" in the last sentence of the second paragraph of Section 2.6**

16. References used in the previous page include a comma after the author and before the year. Choose a format (comma or no comma) and make consistent throughout document.

**All references have been reviewed and revised for consistency. The name of the author and year of publishing are separated with a comma.**

17. Acc. to Table 5, the HI of 0.60 is for all media, not just soil. Is that right?

**The Navy concurs with this comment and the redline changes are accepted in Section 2.7.1 under the Future Adult Construction Workers paragraph.**

18. These findings seem to argue AGAINST the determination that the groundwater poses acceptable risk.

**The following text has replaced the second bulleted item under the "Future Residential Receptors" discussion in Section 2.7.1:**

**"Exposure point concentrations for arsenic in groundwater at the MCL (10 ug/L) and background maximum (12.1 µg/L) present similar risk that exceed EPA's acceptable risk range when compared with the site maximum concentration (20.8 µg/L)."**

19. What does this mean? 1 what? Is there a unit? I've reworded to avoid explaining how adherence factors are determined. Is this okay as edited? If not, explain this "1" business.

**The Navy concurs with this comment and the redline changes are accepted in Section 2.7.1 under the Uncertainty paragraph.**

20. Section 2.8 indicates that there are no remediation goals because remediation is unnecessary.

**The last sentence in the first paragraph of Section 2.9.1 has been revised. "RAO" has been inserted in place of "remediation goals".**

21. I see that this entire section was lifted from the ROD guidance. I am editing for consistent copy edit style within this document.

**The Navy concurs with these changes and all redline edits are accepted in Section 2.10.**

22. I assume no waivers? If a waiver is proposed, it must be included in this ROD and justified here. Please let me know if there is a waiver.

**There are no waivers for this ROD. The suggested redline edits have been accepted.**

23. Not relevant to this criterion.

**The Navy concurs with this comment and all redline edits are accepted in Section 2.10.1, second paragraph.**

24. I assume that there's a letter from the state that can be put into the AR?

**VDEQ will provide a letter upon Navy and EPA signature of the ROD. This letter will be placed in the AR. The suggested redline edit has been accepted.**

25. If the comment period isn't over yet, please highlight this sentence too so it can be checked for accuracy before the ROD is finalized.

**The public comment period is currently underway (March 5 – April 5, 2006). Any comments received during the public meeting will be included in the Responsiveness Summary. The text will remain highlighted until the public comment period is over to ensure the statement is accurate.**

26. Is there any plan that implementation of the LUCs may, one day, be transferred to another entity, perhaps a contractor?

**There are no plans for the Navy to contract NNSY LUCs. No changes were made to the document in response to this comment.**

27. Is this total right?  $\$1,000 \times 30 \text{ y} = \$30\text{K}$ ;  $\$5\text{K} \times 6 = \$30\text{K}$ , minus \$6000 because the annual inspection would be undertaken concurrent with the 5-y review. Thus,  $\$30\text{K} + \$30\text{K} - \$6\text{K} = \$54\text{K}$ . NPW is \$38K?

**The Net Present Worth takes into account the discount factor of money over time (e.g., realizes the value of money over time).**

28. These are the only actions? What about delineation of the location on GIS map of the installation? Free? And enforcement of the restricted access? Subsumed into other restrictions of access?

**The land use restrictions will be included in the base development and Navy-wide program within GIS such that all users of the system will be aware of the land use restrictions related to the site.**

29. CERCLA section 121 (c) requires 5-year reviews for as long as contaminants remain at the site, and requires that the review assess protection of human health and the environment. Although the contaminants at the site do not pose a risk to the environment currently, each review will have to assess whether the remedy continues to be protective of human health AND the environment.

**The Navy concurs with this comment and all redline edits are accepted in Section 2.13.6.**

30. Please check. I presumed that this document was prepared under the same contract as the 2002 document immediately below. I understand that this document is a memo included in the FFS, which is cited above. I include it here as a stand-alone document because it is specifically cited in the ROD. If you have concerns about the public being able to find the document, you could add "(Appended to Baker 2006.)" at the end of the citation.

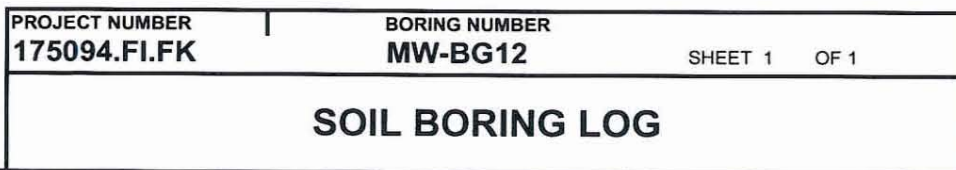
**The Navy concurs with adding the document as a stand alone in the reference section. The reference (appended to Baker, 2006) was also added for clarity.**

31. There's no slash in the EPA document number on my copy.

**The EPA document number in the reference section has been revised to reflect the actual document cover format.**

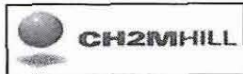
32. Are there slashes in the document numbers on the cover of this document and the two citations immediately following? The references list at the back of the ROD guidance has no slashes, and hyphens between the numbers. The correct citation would be to use what's on the cover of the actual document.

**The actual document cover uses hyphens between the serial numbers. The reference has been revised to reflect the actual document cover format, which includes hyphens.**



PROJECT : CTO-267	DRILLING CONTRACTOR : Drill-Pro	LOCATION : NAS Oceana, VA
ELEVATION :	NORTHING: 3469492.354	EASTING: 12202045.169
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger		
WATER LEVELS bgs	START : 01/02/03-1120	END : 01/02/03-1200    LOGGER : P.Landin

DEPTH BELOW SURFACE (FT)		STANDARD PENETRATION TEST RESULTS		CORE DESCRIPTION	COMMENTS
INTERVAL (FT)		RECOVERY (IN)		SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
			#/TYPE		
5	5-7'	12	1	Fine to medium sand; gray; wet; grading courser with depth, with some clay towards top 6" of core	
10	10-12'	14	2	Medium to fine sand, gray w/ 3" brown sandy clay lense	
15	15-17'	24	3	Medium to fine sand with trace clay in lenses; gray; wet	
20				Boring terminated at 17' bgs	
25					



PROJECT NUMBER  
175094.FI.FK

WELL NUMBER  
MW-BG12

SHEET 1 OF 1

## WELL COMPLETION DIAGRAM

PROJECT : CTO-267

LOCATION : NAS Oceana, VA

DRILLING CONTRACTOR : Drill-Pro

NORTHING: 3469492.354

EASTING: 12202045.169

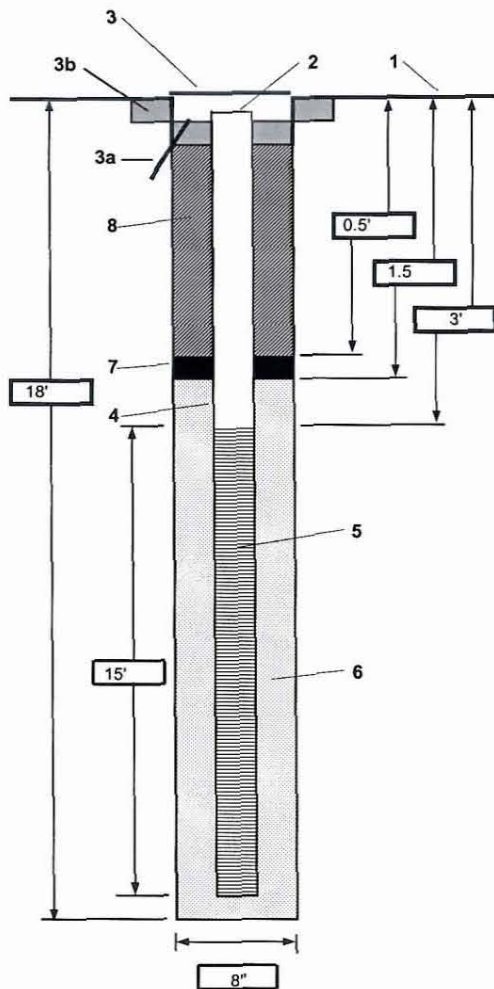
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger

WATER LEVELS : bgs

START : 01/02/03

END : 01/02/03

LOGGER : P. Landin



- |                                   |                          |
|-----------------------------------|--------------------------|
| 1- Ground elevation at well       | _____                    |
| 2- Top of casing elevation        | _____                    |
| 3- Wellhead protection cover type | Stick-up casing          |
| a) drain tube?                    | No                       |
| b) concrete pad dimensions        | 1' diam                  |
| 4- Dia./type of well casing       | 2" PVC                   |
| 5- Type/slot size of screen       | .010 Slot                |
| 6- Type screen filter             | #3 Well Gravel           |
| a) Quantity used                  | 8 bags                   |
| 7- Type of seal                   | Baroid Bentonite Powder  |
| a) Quantity used                  | 1 bag                    |
| 8- Grout                          |                          |
| a) Grout mix used                 | Concrete/Portland Cement |
| b) Method of placement            | Shovel                   |
| c) Vol. of well casing grout      | _____                    |
| Development method                | Whale Pump               |
| Development time                  | 1.25 hrs                 |
| Estimated purge volume            | 75 gal                   |

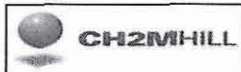
Comments \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
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<b>PROJECT NUMBER</b> <b>175094.FI.FK</b>	<b>BORING NUMBER</b> <b>MW-BG13</b>
SHEET 1 OF 1	
<b>SOIL BORING LOG</b>	

PROJECT : CTO-267	DRILLING CONTRACTOR : Drill-Pro	LOCATION : NAS Oceana, VA
ELEVATION :	NORTHING: 3472721.493	EASTING: 12201118.318
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger		
WATER LEVELS bgs	START : 01/02/03-1020	END : 01/02/03-1100    LOGGER : P. Landin

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)			STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION  SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS  DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone   Above Hole
	RECOVERY (IN)	#/TYPE	#/TYPE			
5	5-7'	0	1		No recovery, blocked by road fill	
10	10-12'	10	2		Fine sand; poorly graded; wet	
15	15-17'	10	3		Fine sand; poorly graded; wet; gray	
20					Boring terminated at 20' bgs	
25						



PROJECT NUMBER  
175094.FI.FK

WELL NUMBER  
MW-BG13

SHEET 1 OF 1

## WELL COMPLETION DIAGRAM

PROJECT : CTO-267

LOCATION : NAS Oceana, VA

DRILLING CONTRACTOR : Drill-Pro

NORTHING: 3472721.493

EASTING: 12201118.318

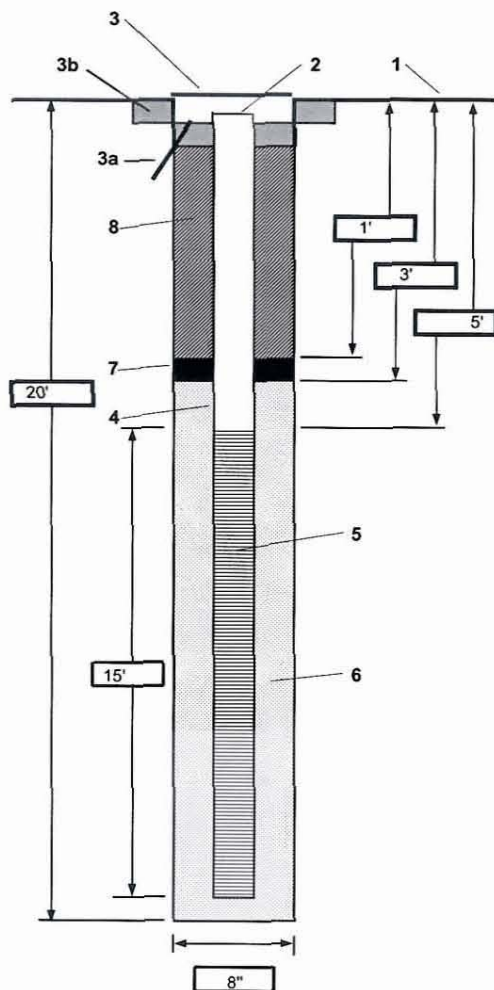
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger

WATER LEVELS : bgs

START : 01/02/03

END : 01/02/03

LOGGER : P. Landin



1- Ground elevation at well	
2- Top of casing elevation	
3- Wellhead protection cover type	Flush Mount
a) drain tube?	No
b) concrete pad dimensions	1' diam
4- Dia./type of well casing	2" PVC
5- Type/slot size of screen	.010 Slot
6- Type screen filter	#3 Well Gravel
a) Quantity used	7 bags
7- Type of seal	Baroid Bentonite Powder
a) Quantity used	1 bag
8- Grout	
a) Grout mix used	Concrete/Portland Cement
b) Method of placement	Shovel
c) Vol. of well casing grout	
Development method	Whale Pump
Development time	62 min
Estimated purge volume	70 gal
Comments	